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PHYSICS.—*Wave lengths of Neon.* IRWIN G. PRIEST. Communicated by S. W. Stratton. To appear in the Bulletin of the Bureau of Standards, **8**: No. 4. 1912.

Ten wave-lengths in the spectrum of neon have been determined by the method of flexure with reflection fringes previously described.[1]

The following values result from a long series of determinations.

TABLE

5852.4862 I.A.	±0.0003
5881.8958	±0.0005
5944.8344	±0.0003
6074.3383	±0.0004
6096.1608	±0.0004
6143.0600	±0.0006
6266.4948	±0.0005
6304.7929	±0.0005
6382.9882	±0.0005
6402.2392	±0.0003

The probable errors are in every case less than one part in 10,000,000. Confirmatory results and counter checks indicate that the values given are accurate within about one or two thousandths of an Ångström unit. A detailed discussion of the accuracy will appear in the complete paper.

PHYSICAL CHEMISTRY.—*The hydrolysis of sodium oxalate and its influence upon the test for neutrality.* WILLIAM BLUM, Bureau of Standards. Communicated by C. E. Waters. To appear in the Bulletin of the Bureau of Standards (Reprint No. 178) and in the Journal of the American Chemical Society.

In connection with the testing of sodium oxalate for use as a primary standard in acidimetry and oxidimetry, a knowledge

[1] Bulletin Bureau of Standards, **6**: 573. 1911.

of its normal alkalinity is essential. Calculations based on the generally accepted theory of hydrolysis, using the most probable values of the dissociation constants, indicate, that in a decimolar solution of sodium oxalate, $[H^+]_{18°} = 2.0 \cdot 10^{-9}$. In such a solution phenolphthalein should be converted into its pink salt to the extent of 7.8 per cent, if we accept the simple theory of indicators, and employ the value $1.7 \cdot 10^{-10}$ as the dissociation constant of phenolphthalein. Pure sodium oxalate was prepared by recrystallization in platinum of two samples, containing respectively slight excess of acid and alkali. After two crystallizations, products of uniform and constant alkalinity were obtained; which was accepted as the criterion of purity. This material was found to produce a color equal to only 4 per cent transfromation of phenolphthalein instead of the calculated 7.8 per cent. Calorimetric comparisons with solutions based based upon Sörensen's E.M.F. measurements indicate that $[H^+]_{18°}$ for 0.1 M sodium oxalate is $2.5 \cdot 10^{-9}$, and that the salt is hydrolyzed at 18° to the extent of 0.0024 per cent. The error involved in a titration for neutrality, if this "normal alkalinity" is neglected, is only about 0.02 per cent, which is practically negligible in all analytical work. It was found that, contrary to statements of Sörensen, sodium oxalate solutions do not decompose on boiling, but that in glass they do become more alkaline, due to the attack of the vessel. Of various kinds of glass tested, "Durax" was found to be most resistant to such solutions. It was also found that commercial samples of sodium oxalate may contain "excess CO_2," either as $NaHCO_3$ or as occluded CO_2; which is not readily expelled at 240°C. Before testing the neutrality of sodium oxalate it is therefore necessary to boil the solutions in quartz or Durax to expel such CO_2.

EVOLUTION.—*Evolution in discontinuous systems.*[1] I. ALFRED J. LOTKA. Communicated by J. A. Fleming.

In the minds of most of us the term "evolution" is associated probably more closely with the biological than with the physical

[1] Paper read before the Philosophical Society of Washington on November 11, 1911.

sciences. Yet the concept is essentially physical in character, and is definable in exact terms probably only in the language of physics. For in its last analysis we may define evolution as *the history of a material system undergoing irreversible transformation.* To the physicist, therefore, the study of evolution is essentially the study of irreversible changes, and the law of evolution is the law of increasing entropy, or, more generally, of the increasing probability of the successive states of any real material system.

Now among the infinite variety of changes of which matter is susceptible, there is a certain class which stands in a measure apart—the so-called "changes of state" in the narrower sense.

If an iron rod is placed in the fire, its temperature rises gradually, and finally the rod may become incandescent. In a perfectly general sense we might speak of this as a "change of state." It is customary, however, to restrict the use of this term to denote such changes as that from ice to water, from water to steam, and so forth. What distinguishes these changes, and places them in a class by themselves, is their discontinuity.

In general the state of a material system may be defined by indicating the values of a number of suitably chosen variables $x_1, x_2. \ . \ .$, and changes in the state of the system then naturally find expression in terms of the changes in the values of these variables. Now in the case of "change of state" in the narrower sense certain of these variables are masses $M_1 M_2. \ . \ .$, for the system is composed of a number of separate portions $A_1 A_2 \ . \ . \ .$, differing from one another in their properties in a discontinuous manner. The mass M_i of any one A_i of these separate portions is in general susceptible of change by the transformation of matter of the species A_i into other forms A_j, $A_k \ . \ . \ .$ It is this passage of matter from one such portion of the system into another or into others, which constitutes "change of state" in the narrower sense.

If, as we noted above, the separate portions $A_1 A_2 \ . \ . \ .$ of which the system is composed, differ from one another in a discontinuous manner, implicitly this conveys the idea, that each portion for itself is in some sense continuous (not necessarily as regards distribution in space). In the realm of physical chemis-

try this continuity shows itself on the one hand in the so-called "phases," on the other hand, in a somewhat different form, in the "chemical individuals," i.e., elements, compounds, dissociates, associates, etc. Quite generally such a continuous portion of a discontinuous system shall be called a "continuum."

Now, aside from the continua known to us in the field of physical chemistry, there are other material aggregates of a very different kind, which display the same continuity, each within itself, while each is fenced off from the others of the same system by a discontinuity: the biological species are of this character.

The term "species" is here used provisionally, as being the word in our existing vocabulary which most nearly expresses my meaning. For the sake of exactitude and to avoid conflict with biometricians, who have appropriated the term "species" for use in a more restricted sense, it will be preferable to employ some other phrase, such as "kindred-group," to denote a group of organisms that stand in blood-relationship to one another, either actually or potentially.[2]

It is worth while to note in passing, that the cause of the continuity within a kindred-group lies in its mode of growth: A germ of the parent-substance serves as the nucleus for the formation of the young individual, which, by heredity, resembles its parent. This is what Wo. Ostwald[3] has called "autocatakinetic growth," in analogy with the autocatalytic growth of the solid phase upon a crystal germ introduced into a supersaturated solution.

Two other types of aggregates deserve brief mention. In the beehive, the anthill, or a human community we have instances of a "social continuum." Such a continuum comprises a number of different social elements joined together in a definite, though not invariable proportion, a proportion essential for the proper functioning and life of the continuum. Such an aggregate also

[2] Barren hybrids, such as the mule, are here to be left out of account; in nature they will presumably never number more than a small proportion of the total of the crossed groups.

[3] Über die zeitlichen Eigenschaften der Entwickelungsvorgänge; published by W. Engelmann, Leipsic 1908, in the series "Vorträge und Aufsätze über Entwickelungsmechanik der Organismen," edited by W. Roux; p. 36.

grows by autocatakinesis, each new portion added resembling in general character the original stock.

The third and last type of biological aggregate which we shall note here is seen in its fullest development in connection with the human race. From the moment when man learnt to till the soil, to raise cattle, and so forth, when therefore the crop in the field, the herd upon the pasture grew in synchronism and in *controlled proportion* with the human population, from that moment man, together with the plant and animal stock raised and nurtured by him, formed one "economic continuum." This again grows by autocatakinesis, and is seen in its most highly developed type in modern civilized man and his agricultural, industrial, commercial and political equipment.

To recapitulate, we have noted the following types of continua:

1. Physical continua—Phases.

2. Chemical continua—Elements, Compounds, Associates, Dissociates.

3. Biological continua—(a) Physiological: Kindred-Groups (Species). (b) Sociological: Societies. (c) Economical: Economic systems.

A complete discussion of the subject of "Evolution in Discontinuous Systems" should, then, cover all those "changes of state," in which any of the types of continua noted in our table are suffering changes in *character* or in *mass*. It would therefore include the physics of change of state, the whole of physical chemistry, the study of radioactive transformations, and the discussion of certain biological, sociological, and economic questions.[4] I propose to restrict myself here on the one hand to considerations relating to the subject as a whole, as embodied in this introduction, and on the other hand to the treatment of one or two specific examples which have not hitherto received much attention from this point of view.

A point has just been touched, which requires our more detailed consideration: the dual character of the changes to which a continuum is subject, namely changes in character and changes

[4] Compare A. J. Lotka, Am. Jl. Sci. 24: 216, 1907, the first paragraph of the summary.

in mass. The simplest example in point comes to us from physical chemistry. In general a change of state, such as crystallisation from a supersaturated solution, involves a change in composition, as well as in mass, of one or more phases.

When we turn to biological systems, composed of a number of "kindred-groups," we observe an analogous state of affairs. In general the individuals comprised within a kindred-group are not all precisely similar. Thus, expressing the matter analytically, out of a total N_1 of individuals of some group A_1, a certain fraction

$$N_1 C_1 (p, q, r, \ldots) \, dp \, dq \, dr \ldots$$

will have the values of certain characteristic features P, Q, R, . . . comprised between the limits

$$\begin{aligned} &p \text{ and } (p + dp) \\ &q \text{ and } (q + dq) \\ &r \text{ and } (r + dr) \\ &\ldots\ldots \end{aligned}$$

A similar statement holds for each of the other groups A_2, A_3, . . .

As time goes on both the values of N_1, N_2, . . . will in general change, and also the form of the frequency functions C_1, C_2, . . . In other words, the matter of the system undergoes a change in distribution: (1) among the several kindred-groups; (2) among the several types of individuals of which each group is composed. The former change may be spoken of as "Inter-Group Evolution," the latter as "Intra-Group Evolution."[5]

It is intra-group evolution, the change in time of the character of a species, with the possibility of the origin of a new species as its outcome, which has hitherto mainly engaged the attention of the biologist.

We, on the contrary, will here turn our attention chiefly to certain aspects of inter-group evolution.

[5] Annalen der Naturphilosophie, p. 69. 1911.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The density and thermal expansion of linseed oil and turpentine.* H. W. BEARCE. Bulletin of the Bureau of Standards. 1912.

Sixteen samples of linseed oil and twelve samples of turpentine were examined with a view to determining their physical and chemical characteristics; special attention was given to the density and thermal expansion. Tables have been prepared for obtaining the densities of these substances at temperatures between 10° and 40° C. from their densities at a single temperature; also conversion tables for changing pounds to gallons and gallons to pounds. H W. B.

PHYSICAL CHEMISTRY.—*Preliminary report on the ternary system* $CaO-Al_2O-Si_2O_2$. *A study of the constitution of Portland cement clinker.* E. S. SHEPHERD and G. A. RANKIN, with optical study by FRED. E. WRIGHT, Geophysical Laboratory. Journal Industrial Engineering Chemistry, **3**: 1. 1911.

In the earlier work with mixtures of pure lime and silica, two compounds, the metasilicate ($CaO.SiO_2$) and the orthosilicate ($2CaO.SiO_2$), were definitely established, but no trace of the hitherto generally accepted tricalcic silicate ($3CaO.SiO_2$) could be found in mixtures of pure lime and pure silica. In the three-component system, on the other hand, the tricalcic silicate appears promptly with the addition of alumina to mixtures of appropriate lime-silica concentration, and after a long and difficult experimental investigation, involving the study of about 1,000 heat treatments of various compositions, many of which required to be studied at temperatures between 1800° and 1900° C., it has finally been prepared pure, excepting for a small excess (between 1 and 2 per cent) of orthosilicate or lime or both.

Tricalcic silicate appears to be unstable at its melting temperature, and so does not form from a melt of this composition. For the same reason, it does not form eutectics with the adjacent compounds, calcium

orthosilicate and lime. Neither is there any evidence that the tricalcic silicate takes up calcium orthosilicate or lime in solid solution.

In addition to the tricalcic silicate, a new and probably unstable form of the orthosilicate has been discovered which may prove to be of importance in Portland cement.

The general boundaries of the different phases occurring throughout the entire diagram of the ternary system $CaO-Al_2O_3-SiO_2$, have been established, together with the course of the boundary curves. From these it is possible to predict the compounds which will crystallize out of a lime-silica-alumina cement of any composition, provided only that the compounds are intimately mixed and the heat is sufficient to bring the mixture to equilibrium during formation. The exact location of the quintuple points, with the exception of points 13 to 17, and the isotherms remains to be established. The location of these quintuple points is as follows:

POINT	17	16	15	14	13
CaO	59.5	58.5	52.8	49.2	48.5
Al_2O_3	32.5	33.0	40.5	44.0	42.0
SiO_2	8.0	8.5	6.7	6.8	9.5

Portland-cement clinker within the concentration limits set by Richardson, *when in equilibrium*, may exist in the following combinations, depending primarily upon relatively small changes in the quantity of lime present:

I	II	III	IV	V
CaO	$3CaO.SiO$	$2CaO.SiO$	$2CaO.SiO_2$	$2CaO.SiO_2$
$3CaO.SiO_2$	$2CaO.SiO_2$	$3CaO.Al_2O_3$	$5CaO.3Al_2O_3$	$2CaO.Al_2O_3SiO_2$
$3CaO.Al_2O_3$	$3CaO.Al_2O_3$	$5CaO.3Al_2O_3$	$CaO.Al_2O_3$	$CaO.Al_2O_3$

Richardson's typical cement corresponds to class II. The relative cement-forming value of the above mixtures has yet to be determined. The more intimate the mixture of the raw material, and the more uniform the heat treatment, the closer will be the approach to equilibrium and therefore to constant relations and the more uniform the behavior of the final product. Classes III and IV are predicted from the general direction of the boundary curves and the quintuple points 14 and 15. Class V will occur in cements low in lime and will differ only in the relative amounts of the different phases from pure slag cements whose compositions lie below the line joining the calcium orthosilicate and

$2CaO.Al_2O_3.SiO_2$ compositions. Type V is dependent on the nature and location of point 13 and is to be regarded as tentative.

If solid solutions are formed they are very limited in extent and are not sufficient to affect the optical properties of either silicate, the lime or the aluminate. This fact serves to give greater definiteness to the problem and an unexpectedly clear field for studies of the cement-forming quality of clinkers of nearly related composition but different chemical constitution. It therefore seems inevitable that such studies will lead to more reliable standards in cement practice.

The diagram indicates that the constitution of slag cement will be seriously affected by relatively small differences of composition in the neighborhood of the line joining the compounds calcium orthosilicate and $2CaO.Al_2O_3.SiO_2$. It is, however, unwise to draw positive conclusions about the character of this portion of the diagram until it has been more carefully studied.

Incidentally, it has been observed that Fe_2O_3 appears *not* to form solid solutions with CaO, $2CaO.SiO_2$, or $3CaO.Al_2O_3$. It does appear to react in some way with $5CaO.3Al_2O_3$, but the nature of this reaction has not yet been studied. Attention should also be called in passing to the important fact that Fe_2O_3 dissociates at about 1400° with the formation of Fe_3O_4.

Finally, too great importance can not be given to the constant use of the microscope in cement study and practice. It is not improbable that microscopic examination will eventually provide much of the information desired about the constitution of test samples, with the advantage over chemical methods of giving immediate results.

It remains to determine the isotherms of the diagram and to determine whether or not the five typical "clinkers" possess any differences in properties when hydrated to form cement. The work on the isotherms is well under way.

E. S. S. and G. A. R.

MINERALOGICAL CHEMISTRY.—*The mineral sulphides of iron.* E. T. Allen, J. L. Crenshaw, and John Johnston; with Crystallographic Study by E. S. Larsen. Am. J. Sci. (In press.)

The formation of iron disulphide was accomplished (1) by the action of hydrogen sulphide on ferric salts, or the action of sulphur and hydrogen sulphide on ferrous salts; (2) by the addition of sulphur from solution to amorphous ferrous sulphide or pyrrhotite; (3) by the action of soluble polysulphides on ferrous salts; (4) by the action of soluble thiosulphates on ferrous salts according to the equation $4M_2S_2O_3 + Fex_2 = 3M_2SO_4$

+ FeS_2 + 2Mx + 3S. The first three methods may be generalized as *the action of sulphur on ferrous sulphide:* (1) in acid solutions; (2) in nearly neutral solutions; and (3) in alkaline solutions, since in (1) we may assume that ferrous sulphide first forms by the action of hydrogen sulphide on the ferrous salt, and in (3) we know that polysulphides first precipitate a mixture of ferrous sulphide and sulphur. Marcasite was obtained with certainty only by method (1); low temperatures and free acid favor its formation. A solution containing about 1 per cent of free sulphuric acid at 100° gives pure marcasite. Less acid solutions at higher temperatures give mixtures of marcasite and pyrite. The other methods give pyrite, which, under certain conditions, may be mixed with amorphous disulphide. It is possible that some marcasite may be formed by method (4).

Marcasite and pyrite were identified in the above products: (1) by microscopic examination and crystallographic measurement. Marcasite crystals with the proper axial ratio were prepared for the first time; (2) by Stokes's oxidation method. This method serves also for the analysis of mixtures of the two minerals.

Marcasite changes to pyrite with evolution of heat. The change proceeds very slowly at 450° and is not accelerated by pressures even of 10,000 atmospheres. Marcasite is monotropic toward pyrite. This is in accord with the greater inclination of marcasite to oxidize, its assumed greater solubility, and the fact that its formation is conditioned by the composition of the solution from which it crystallizes.

The fact that marcasite never occurs as a primary constituent of magmas, while pyrite sometimes does, is explained by the fact that marcasite can not exist above 450°. The formation of pyrite in deep veins and hot springs is explained by the fact that the waters from which it came contained no strong acid. The marcasite of surface veins was probably formed from cold acid solutions, while mixtures of marcasite with pyrite were probably conditioned by higher temperature (up to 300° or 400°), or the presence of less acid, or both. Micro-organisms may have been active in the formation of pyrite and marcasite by giving rise to hydrogen sulphide.

Pyrrhotite was formed by the decomposition of pyrite or by heating marcasite, or by heating iron with excess of sulphur. The dissociation of pyrite into pyrrhotite and sulphur is readily reversible. At 565° (about) pyrite and pyrrhotite are in equilibrium with the partial pressure of sulphur in H_2S, which here amounts to about 5 mm. (data of Preunner and Schupp); at 550° in hydrogen sulphide, the pyrrhotite

passes into pyrite, and at 575° the reverse action proceeds. At about 665° the evolution of sulphur from pyrite becomes rapid and a marked absorption of heat results. The pressure of the sulphur-vapor here reaches one atmosphere.

Pyrrhotite is of variable composition. Its composition at any temperature depends on the pressure of sulphur-vapor in which it is heated. Tho it has not been found feasible to vary the temperature and pressure independently, a series of products were prepared by first decomposing pyrite and then reheating the resulting material to various measured temperatures in hydrogen sulphide and then chilling in the same or cooling in nitrogen. The products lowest in sulphur were obtained in the latter way. These products all resemble natural pyrrhotite in physical and chemical properties. Their specific volumes vary continuously with composition and pyrrhotite is therefore to be regarded as a solid solution of sulphur in ferrous sulphide. The maximum percentage of dissolved sulphur in synthetic pyrrhotite was 6.04 per cent at 600°. By extrapolation the saturated solution at 565°, below which point pyrite forms, was estimated to be 6.5 per cent. This corresponds closely to the maximum percentage of sulphur reported in natural pyrrhotite.

Equilibria between pyrrhotite and the partial pressure of sulphur in dissociated hydrogen sulphide were determined at different temperatures, by sufficiently long heating and then rapid cooling. The dissolved sulphur varied under these conditions from 6.0 per cent at 600° to 2.0 per cent at 1300°. The curve shows a discontinuity at the melting temperature, at the beginning of which there is a sudden decrease in the percentage of sulphur.

The melting-point of pure ferrous sulphide could not be exactly determined, because the compound dissociates at high temperatures into its elements. By heating it in a vacuum this dissociation was placed beyond doubt, though the dissociation was so slow that the melting-point could be located approximately. It may safely be put at 1170° ± 5°. In hydrogen sulphide, the melting temperature is raised because the solid solution thus formed contains more sulphur than the first portion of liquid to which it melts. The limits of the melting interval can not be determined as yet, but the maximum heat absorption falls at 1183°. In one atmosphere of sulphur-vapor this temperature rises to 1187°.

Crystals of pyrrhotite, the measurements of which are recorded under the crystallographic study, were repeatedly formed at various temperatures between 80° and 225° by the action of hydrogen sulphide on slightly

acid solutions of ferrous salt containing some ferric salt. The product usually contained some crystals of disulphide.

Troilite is only the end-member of the pyrrhotite series and not a distinct mineral species. Thus far it has not been prepared free from metallic iron. E. T. A.

PHYTOPATHOLOGY.—*The control of the chestnut bark disease.* HAVEN METCALF and J. FRANKLIN COLLINS. Farmers' Bulletin U. S. Department Agriculture No. 467. Pp. 24, figs. 4. 1911.

This bulletin describes the chestnut bark disease and recommends methods for its control. This disease, caused by the fungus *Diaporthe parasitica* Murrill, first came prominently to the public attention in 1904, and since that time has proved itself perhaps the most serious tree disease known to science. First noted in the general vicinity of New York City, it has now spread into at least ten States. It attacks the American chestnut, the European chestnut, the chinquapin, and, rarely, the Japanese chestnut; but so far has not been found growing parasitically outside of the genus *Castanea*. The total financial loss is now estimated at $25,000,000. If the disease is not controlled thru human agency, there appears to be no reason to doubt that the chestnut tree will become largely extinct in North America within the next ten years. The fungus gains entrance at any point where the bark is broken, borers' tunnels forming the most common means of entrance. From the point of entrance, the disease spreads primarily in the inner bark and produces characteristic lesions which girdle the tree at the point attacked.

Conspicuous symptoms are the development of bunches of sprouts below the girdling lesions; the half-formed yellowish leaves in the spring on the previously girdled branches; the reddish-brown leaves on branches girdled in summer, and the yellow, orange, or reddish-brown pustules of the fruiting fungus on the bark. It is practically useless to attempt systematic location of the disease from October to April, inclusive.

The spores may be carried considerable distances on chestnut nursery stock, tan bark, and unbarked timber; also by birds, insects, squirrels, etc., which have come in contact with the sticky spore masses. Water quickly dissolves these spore masses and the minute spores are in this way carried along with water, as, for instance, with rain water running down a tree.

The only known practical way of controlling the disease in a forest is to locate and destroy the advance infections as soon as possible after they appear and, if the disease is well established near by, to separate

the area of complete infection from the comparatively uninfected area by an immune zone. Advance infections should be located by trained observers and destroyed by cutting and burning. As the disease develops almost entirely in the bark, this must be completely destroyed (burned).

In order to carry out the above methods it is essential that the several States concerned secure necessary legislation and appropriations, following the example of Pennsylvania, as no law exists whereby the federal government can undertake such work and coöperation among private owners without State supervision is impracticable.

Chestnut nursery stock should be rigidly inspected for the disease and only perfectly healthy plants passed.

The life of valuable ornamental trees may be greatly prolonged by promptly cutting out all diseased areas and removing all disease-girdled branches and then covering the cuts with tar. Spraying is of no use in stopping the fungus after it has once started growth in the bark.

It is recommended that owners of infected woodland cut down and utilize the diseased chestnut timber as soon as possible.

For the present the planting of chestnuts anywhere east of Ohio is not advised, but there is no apparent reason why chestnut orchards west of Ohio may not be kept free from the disease. H. M

PHYTOPATHOLOGY.—*Root knot and its control.* ERNST A. BESSEY, Bureau of Plant Industry. Bulletin No. 217, pp. 89, 3 pl., 3 figs. 1911.

The disease known as root knot is abundant in sandy soils thruout the warmer parts of the United States and more sporadically in other regions. It is due to the attack of a nematode, *Heterodera radicicola* (Greef) Müller, a near relative of the European sugar beet nematode, *H. schachtii*. The disease was first recognized in Europe in 1855. Its first mention in print in this country seems to be in the latter part of the eighties altho it had been observed by florists in greenhouses as early as 1876. It has been found to be present in North and South America, West Indies, Europe, Asia, Africa, East Indies, Australia and Hawaiian Islands. It seems to be tropical in its origin, probably having been native to the Old World. A list of plants susceptible to root knot is given, including 480 species, on 291 of which the author observed the parasite himself, the highest previous list including only 235 host plants. The plants included represent almost all of the more important families of dicotyledons and monocotyledons as well as one gymnosperm and one

fern. They include both herbaceous and woody plants and annual, biennial and perennials. The anatomy and development of the parasite is discussed, followed by a comparison between this nematode and the one causing the disease of the sugar beet in Europe, they having been shown to be decidedly distinct as long ago as 1890 by Voigt. It is shown that the chief method of introducing the pest into a new location is by means of live plants, especially nursery stock, and when once introduced, it spreads from place to place in the soil adhering to tools, hoofs of animals, wagons, etc. The presence of the nematode within the roots causes hypertrophy of the tissue resulting in a gall. These galls are usually confined to the roots but in some cases were seen to occur on the stems, leaves and fruits where these have come in contact with infested ground. The water-conducting tissues within these galls are very much twisted and dislocated so that when the galls are abundant, the plants are subject to wilting much more easily than the uninfected plants. These fleshy galls also form the center of infection for various parasitic fungi. Conditions favoring root knot are high temperature and sandy soil with plenty of moisture altho the soil must not be entirely saturated. This pest is practically inactive at a temperature lower than 10° C., but is able to survive in unprotected soils at −35° C. The control of root knot is discussed under the following headings: Greenhouses, seed beds, etc.; in the field with no crop present; and in the field occupied by perennial crops. In the first, live steam is most satisfactory altho fresh soil can be used if obtainable nematode free, and formaldehyde, one part of 40 per cent solution to 100 parts of water, is successful under certain conditions. In the field with perennial crops, practically no treatment is satisfactory except the stimulating of the plants to abundant growth by the use of extra amounts of fertilizers. For exterminating the pest in fields not occupied by perennial crops, rotation methods with non-susceptible crops were the most successful. Those that were most successful in the South were the use of Cowpeas ((*Vigna unguiculata*), Velvet Bean (*Stizolobium deeringianum*), Florida Beggar weed (*Meibomia mollis*). Only the non-susceptible varieties of the first can be used, for example, the variety known as Iron. These are grown as summer crops and in the fall rye or oats is sown. Two years of each crop is necessary to free the field and in some cases perhaps three would be more successful. There seems to be considerable promise in breeding varieties that are non-susceptible to the trouble. **E. A. B.**

FORESTRY.—*Reforestation on the national forests.* WILLIAM T. COX. Bulletin Forest Service, No. 98. 1911.

Next to the importance of protecting the national forests from fire and disposing of the mature timber to secure good natural reproduction is the task of starting forest growth upon the vast areas of untillable mountain lands which have been rendered unproductive by fires, insects, and other agencies. Of this class of land within the national forests there are approximately 7,500,000 acres which must be artificially sown or planted. The policy of the Forest Service in artificial reforestation on the national forests is first, to conduct experiments to find out what can be done, and what is the best way to do it; second, to reforest by direct seeding where this is possible; and third, to plant nursery seedlings where direct seeding is too uncertain. In selecting sites for artificial reforestation preference is usually given in the following order: First, watersheds of streams important for irrigation or municipal water supply; second, lands which produce heavy stands of quick-growing trees; third, lands suitable for the production of especially valuable species, or where conditions are favorable for improving the character of the forest; fourth, sites which offer good opportunities for object lessons to the public in the practice of forestry; and fifth, denuded lands which have no special claim for attention except that they will grow some kind of trees. The Forest Service itself collects most of the seed of native tree species needed for planting on the national forests. This is done usually for considerably less than the seed would cost if purchased from regular collectors of seed growers. During the autumn of 1910 it collected 107,780 pounds of native tree seed, and purchased 54,100 pounds of the seed of European species, a total of 161,780 pounds. There are three methods of collecting cones; from felled trees, from standing trees, and from squirrel hordes. The cones are dried and the seed extracted promptly after collection. Some cones can be opened by spreading them on canvas sheets to dry in the sun. Other species must be taken to the drying house and opened by artificial heat.

Of the two methods of artificial reforestation—direct seeding and planting—the first offers for certain species on many of the national forests by far the greater promise of success. In general, hardy trees, the seed of which is easily and cheaply obtained, can be reproduced satisfactorily by direct seeding, while species like red pine, which bear small crops of seed that are difficult to collect, can be reproduced more cheaply by planting. W. T. C.

FORESTRY.—*Columbian mahogany: Its characteristics and use as a substitute for true mahogany.* GEORGE B. SUDWORTH and CLAYTON D. MELL. *With a description of the botanical characters of Cariniana pyriformis.* HENRY PITTIER. Circular Forest Service, No. 185. 1911.

One of the best imitation mahoganies now marketed is the so-called Columbian mahogany *Cariniana pyriformis*, Miers. It is not true mahogany, but belongs to an entirely different family of trees, the monkey-pod family, *Lecythidaceae*. The true mahogany, *Swietenia mahagoni*, Jacq., is a member of the family *Meliaceae*, to which the well known China tree belongs. Tho the consumption of material passing in the markets as mahogany amounts annually to about 40,000,000 feet, the cut of real mahogany is only about 18,000,000 feet. How long the wood of *Cariniana pyriformis* has been used in the United States for mahogany is not known. It has been exported from Cartagena, Columbia, to Havre, France, for more than thirty years, and there sold in immense cargoes as genuine mahogany. Practically all of the "Columbian mahogany" now marketed is cut at points from 100 to 200 miles inland, and shipped from Cartagena. Columbian mahogany and true mahogany are as botanically unlike as an oak and a maple, but a superficial resemblance in the grain and color of their woods has made it possible to substitute the Columbian wood for the other. It seems possible now when the demand for mahogany is greater than the supply that there could be accepted use for such woods as *Cariniana pyriformis*, acknowledged not to be mahogany, but which are so similar to it in color, grain effects, and working qualities, as to serve for the rarer wood. There should be no objection to calling such woods by their proper names.

Cariniana pyriformis first became known botanically in 1874, while true mahogany was first described in 1760. Adequate information regarding the botanical characteristics of *Cariniana pyriformis* and of the structural nature of the wood has never before been published.

G. B. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 41st annual (701 regular) meeting was held on December 9, 1911, President Day in the chair. The meeting was devoted to hearing the annual reports of the secretaries and the treasurer, and to the election of officers for 1912. The following were chosen:

President: E. B. ROSA. Vice-Presidents: C. G. ABBOT, G. K. BURGESS, W. S. EICHELBERGER, L. A. FISCHER. Treasurer: L. J. BRIGGS. Secretaries: W. J. HUMPHREYS, R. L. FARIS. General Committee: WM. BOWIE, E. BUCKINGHAM. E. G. FISCHER, J. A. FLEMING, B. R. GREEN, D. L. HAZARD, R. S. HARRIS, P. G. NUTTING, F. A. WOLFF.

R. L. FARIS, *Secretary.*

THE BOTANICAL SOCIETY OF WASHINGTON

The 76th regular meeting of the Society was held at the Cosmos Club, Tuesday, December 5, 1911. President W. A. Orton presided. Thirty-three members were present.

The following papers were read:

Thrips as pollinators of beets. HARRY B. SHAW.

Thrips tabaci were observed to be numerous on seed beets in Utah. They were always abundant on flowering racemes, as many as 190 being collected from one small branched raceme. They were not observed to interfere with seed production. On the contrary, it appeared more probable that they acted as agents of pollination. An examination showed them to bear numerous pollen grains scattered about their bodies. As many as 140 beet pollen grains being counted on one adult thrips. An experiment, started August 7 and 8, 1911, under carefully arranged isolation conditions on emasculated beet flowers, resulted in 17.2 per cent of the flowers to which thrips had been introduced being fertilized and producing seed. All the controls remained sterile. The conclusions are that thrips are probably important beet pollinators; that they may act similarly with other plants; that their absence or too small number may account for the non-fertilization of flowers in some localities and seasons; that they may fertilize flowers under supposedly isolation conditions and may even cross plants not regarded as capable of being crossed by insects, e.g., barley; and that they may also spread fungus spores and bacteria.

Forest types. RAPHAEL ZON.

An ecological survey of the forests of western Idaho, in connection with the preparation of yield tables, revealed three main forest types, or, in the terminology of ecologists, "formations." Two of these are final or

climax and one an intermediate or transitory type. The climax types are yellow pine-Douglas fir and cedar-hemlock. The transitory type is white pine-larch. The yellow pine-Douglas fir is both a pioneer and climax type. When burned or cut over it invariably succeeds itself. The cedar-hemlock type is a climax type preceded by the larch-white pine. The order of succession from the pioneer to the climax forest is as follows:

First the larch (*Larix occidentalis*) comes in as the pioneer, shading the ground and offering the protection necessary in order that the white pine (*Pinus monticola*) might establish itself. The white pine, soon after becoming established, begins to crowd the larch, overtopping and exterminating gradually all but the most vigorous specimens. Under the shading of the white pine and larch cedar (*Thuja plicata*), hemlock (*Tsuga heterophylla*), and white fir (*Abies concolor*), begin to come up, crowd out the white pine and finally become the sole occupants of the ground.

This ecological study had a practical bearing upon the management of the forest as it pointed out the possibility of leaving larch and selling the white pine, which alone at present commands any price, without danger of eliminating it from the future stands. This study furnishes a concrete example of the value of ecological studies as a basis for forest management.

Phytochemical Studies on Cyanogen. DR. C. L. ALSBERG and O. F. BLACK (by invitation).

W. W. STOCKBERGER. *Corresponding Secretary.*

PROGRAMS AND ANNOUNCEMENTS

PHILOSOPHICAL SOCIETY

702nd Meeting, January 6, 1912. Cosmos Club at 8.15. R. A. HARRIS: *Krümmel's Handbuch der Ozeanographie, Vol. II.* J. M. MILLER: *The Determination of the Pole Distance of a very Small Magnet.*